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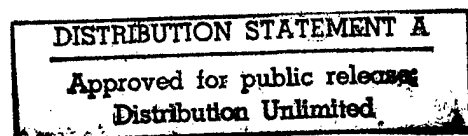
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**"Battlefield Dominance and Missile Defense
in the 21st Century"**

**Remarks of
The Under Secretary of Defense for Acquisition and Technology
Honorable Paul G. Kaminski**

**to the
ADPA/AUSA Symposium
Redstone Arsenal, Huntsville AL**

January 16, 1996

Ladies and gentlemen, it's a great pleasure to be with you here at Redstone Arsenal this evening. . . Redstone and the U.S. Army Missile Command have a rich tradition of providing our country with the winning edge. . . America will continue to rely on your innovation, skills and expertise to field land combat, air defense and aviation missile systems that are second to none.

From a missile defense planning perspective, this is a very important time for all of us. When I leave Washington for a visit like this, I find that I benefit enormously from my interaction with all of you, so I plan to leave time for questions and answers. This type of interaction is important to me.

Last December, Gil Decker and I had the wonderful opportunity to be hosted by Major General Jack Costello, at Fort Bliss. While we were there, we met with the soldiers operating our currently fielded air and missile defense systems like the Patriot, Avenger, and the supporting Battlefield Management Command Control, Communications, Computer, and Intelligence (BMC4I).

We also met with the soldiers preparing for and supporting equipment under development, systems like the THAAD and JTACS. It was a very rewarding experience for me to see the equipment, to gain an understanding of how it is employed, but most of all to see our very capable soldiers, who are exploiting this equipment to its full potential. How blessed we are as a nation to attract and retain such able people in our armed forces!

As I visited MICOM today--for the first time ever--I was left with a similar impression. . . how blessed we are as a nation to attract and retain the technical and management talent that I met today.

MISSILE DEFENSE STUDY

My experience at Ft Bliss and this afternoon at Redstone is sobering for me,

causing me to take very seriously the responsibilities I have in helping to chart a course for the future of our missile defense programs. I have been involved in a total review of our missile defense programs for a few months now. We are now putting the finishing touches on that review as we prepare the FY 1997 budget. Since that budget has not yet been finalized, I am not prepared to discuss the final results of the review tonight. Instead, I am prepared to share with you my thoughts on the objectives, approach, and principles underlying this review.

First, our objective was to seek a balance between what I would describe as the external and internal components of our missile defense capability. For the external we were trying to balance our investment in other priority programs, such as trucks, ships and fighter aircraft, with our BMD programs. The Joint Staff felt that we were spending too much at \$3 billion per year on BMD. Some believed that we should have a target ceiling of \$2.5 billion or maybe even as low as \$2 billion per year. We considered these targets during our review, but we were not driven by them.

For the internal balancing, we had three levels upon which we focused. The first level would be the pillars, which are active defense, passive defense, attack operations (which includes some of our external capabilities) and BMC4I.

As we dropped to the second level, we focused on the capabilities and systems which comprise active defense. They consist of the lower tier systems, the upper tier systems, Boost Phase Intercept and the enabling BMC4I. As we dropped down one more level we took a more detailed look at specific missions and the capability required to address those missions.

Our approach was to consider first the requirements and their priority, while also reviewing the underlying acquisition strategy. To assist us in this task we considered several elements such as:

- (1) **Maturity**--We need to consider and account for the difference between well defined systems and "view graph engineering." During our review we considered the fact that the more mature the system or capability, the more apparent would be the known limitations. A more mature system would also have more reliable cost data.
- (2) **Executability**--Is this program executable? What are the risks and are they prudent risks considering the maturity and the urgency of the need?
- (3) **Critical Mass**--At what funding levels do we go below a critical mass, with output so low that we are better off to make a termination decision.
- (4) **Stability**--How can we plan to obtain long term stability in the program, to

include consideration of external influences which could effect its execution.

- (5) **Competitive Forces**--How to make use of dissimilar as well as head-to-head competitive approaches for similar missions. This caused us to add the business strategy as an important consideration.

As the conduct of our review progressed, the importance of BMC4I grew. That importance has been reinforced by my visit here today. This is what I want to focus on in the remainder of my remarks tonight.

DOMMINANT BATTLEFIELD CYCLE TIME

During the cold war, our intelligence systems were cued to a relatively stable, predictable set of targets for exploitation. An example was obtaining intelligence on weapons systems being developed by our adversaries. Our national intelligence systems were not well integrated with our combat forces. Today, we must cope with a more dynamic environment in which there is an expanded range of ambiguous, unpredictable threats.

To counter the proliferation of weapons of mass destruction, increase the effectiveness of attack operations against enemy ballistic missile launchers, and facilitate an improved cruise missile defense, our battle management and intelligence systems need to be considerably more robust and timely in collecting multi-source and continuous surveillance data. . . as well as storing, processing, disseminating and managing much larger quantities of information.

The coming decades promise a quantum shift in the evolution of armed conflict. Our forces are being designed to achieve dominant battlefield awareness and combat superiority through the deployment of fully integrated intelligence systems and technologically superior weapons systems.

Dominant battlefield awareness is critical, but it is not the whole story. It is a necessary condition, but not a sufficient condition to prevail on the 21st century battlefield. What one really needs is something I call "dominant battle cycle time." This is the ability to turn inside an adversary; to act before the adversary can act.

A more stressing objective is to be able to act before the adversary's battlefield awareness system can see you act. In addition to possessing a dominant battlefield awareness capability, achieving a dominant battle cycle time capability means one also must possess rapid planning tools, strong command and control systems, and superior mobility.

TEN ENABLING TECHNOLOGIES

As I envision the future, I see at least ten enabling technologies and architectural concepts that are needed to build dominant battlefield cycle times. Many of these BMC4I technologies and concepts are being deployed to better support our troops in Bosnia.

1. Advanced processing

The first key technology is to continue to build on advances in processing. Here a key issue will be the ability to do more on-board processing as well as to increase our capability to do off-board processing. The general trend we have seen since the 1970s as a result of increasing the number of gates per chip by decreasing the minimum feature size of a chip device has been about a ten-thousand fold improvement in capability while cost has been held nearly constant.

(Chart 1 On)

These advances in processing are proceeding at a rate described by Moore's Law, illustrated on this first chart. We project that we will have another thousand fold improvement over the next 15 years at the rate of advance predicted by Moore's Law.

I would wish to make two points here. One is that there is an enormous amount of improvement ahead for us to make great strides in both on-board and off-board processing, and they are strides that will be needed to digest all the data collected.

Second, we do see an end to the linear relationship predicted by Moore's Law. It is 10 or 15 years out. That end was seen 20 or 25 years ago and nothing has changed our forecast of it. At that time we will be getting down to device sizes in which we are dealing with geometries that incorporate only a few hundred silicon atoms.

So we will need to invent some new approach which may exploit different physical principles to make smaller devices and continue making processing advances. This is an area in which we will need some partnership involving government, universities and industry. As I said, it is still 10 to 15 years ahead, but it is something that in five years or so we will probably have to be researching in a more systematic way.

(Chart 1 Off)

2. Automatic Target Recognition (ATR)

The next key technology area will employ advanced processing and has to do with the field of automatic target recognition and other productivity enhancement tools

for our image analysts. The ATR problem has been reported to be "solved" at least twice before in this decade. Not so. As we deal with the problem of sensory overload, we will have to do more and more automatically. We are investing on the order of \$100 million per year in this area, but it is an area which can be better focused.

ATR will be key for providing the cueing for the sequential collection approach I will describe later. While there is much to be done to help us extract information from data, I note that this audience is as experienced as any, having dealt for years with the problem of extracting useful information from air defense radars. As we become saturated with more and more data, this will be one of the most critical pillars in the building blocks that I have been describing. The third, a key architectural concept has to do with indexing all collected information to common grids.

3. A Common Grid

The idea is to be able to access all the data that we have collected and to have a built-in indexing system. One natural way to index is based upon the location where the information is collected. . . and we can do that with a three dimensional position tag and also with a precise time tag.

A common grid, in combination with a distributed and open architecture, gives us the ability later to go back and fuse information that was collected at previous times or to look at correlation's of events. This kind of index is essential to the development of very large, dynamic databases that we will be able to use to retrieve and correlate information.

(Chart 2 On)

A common grid would also give us the flexibility to do coherent processing after the fact. A grid that has a fine position and timing capability, positions on the order of feet, timing on the order of nanoseconds, would support after-the-fact processing using multiple sensor systems, to include those in space, on manned or unmanned aerial vehicles, on ships, or on the ground.

(Chart 2 Off)

4. Distributed and Open Architectures

The fourth key concept has to do with the creation of distributed and open architectures. You may think of this as "plug and play," in which a variety of collection systems can play together in a compatible way. A good example is our Joint Airborne SIGINT Architecture or JASA. We want an architecture that can accommodate our large and small satellite collectors, unmanned aerial vehicles (UAVs), unattended ground sensors and one which can accommodate and deal with HUMINT and other

intelligence sources. The sensor architecture has to be able to accommodate commercial collection systems and processing and do so in a distributed and open manner.

5. Sequential Application of Off-Board Collectors

The idea here is the informed, sequential tasking of our intelligence, surveillance and reconnaissance collection resources. You can think of this concept in terms of selecting the right spectral frequencies. . . over the right area and resolution. . . and doing this over the right period of time.

We are now planning to make tenfold improvements in multi-spectral sampling, through combinations of radar, infra-red and electro-optical wavelengths, while at the same time, making a tenfold increase in the area of resolution of collection systems, and then on top of this, making a tenfold improvement in the continuity of coverage, moving towards around-the-clock day-and-night coverage under all weather conditions.

The problem is that if we make all these improvements simultaneously, we are looking at a ten times ten times ten, or thousand fold increases in the data to be analyzed and processed for the user. That is probably not something we can deal with. Neither could we probably afford the full combination of collection systems.

(Chart 3 On)

So the idea is not to apply all the improvements simultaneously. The concept is to be able to operate sequentially, to do some sampling, with technologies that may in a sensible way pick the appropriate path. . . in the appropriate spectral frequency band. . . over the area of interest at the proper resolution. . . and at the right time interval. . . to produce information that can be suitably digested and acted upon.

The idea is illustrated in this chart. Smart sequential tasking allows us to chart an appropriate path in three dimensions rather than fill the whole volume.

(Chart 3 Off)

6. Data Compression

Digital processing techniques, such as data compression, will be used to limit transmission bandwidth or to provide on-line storage of data when we have limited storage.

Recently I visited CNN, who is putting on-line their first digital video storage system, and one of the keys is the compression technique they are using to minimize the

storage required to have large video databases on-line. Data compression will be key to storing and transporting large data bases.

7. Very Large, Dynamic, Object Oriented Data Bases

The extent to which we are able to store the data collected and to put the data into systematic indexed databases, indexed in the way I was describing earlier based upon position, time and other key features, will be the key to our ability to fuse data and intelligently query these large databases.

In the past, when our forces deployed, there were a number of critical items, such as food and ammunition, on the critical deployment list. In the future, data bases will be on this critical deployment list. We must put much energy into deciding what databases to deploy with our forces as they move forward so they do not have to reach back to the CONUS unnecessarily. This will require theater data bases of 10 to 100 or perhaps even 1000 terabits.

We need the ability to leverage off of commercial developments, and there is also some very high leverage work required here to develop something that I would describe as a mediator to be able to deal with the various disparate databases that will be out there -- commercial, open and otherwise.

8. Data Storage

Here again, the commercial market is leading the way. Improvements in data storage are also following the Moore's Law curve that I discussed earlier and so we have about a thousand fold improvement yet to go here as well.

The problem that we in the Department of Defense and the Intelligence Community face is that our total storage requirements are on the order of ten to the 15th bits--larger than the Library of Congress. We have recently developed a new commercial digital video standard high-end device that stores about six gigabits per disk.

The problem is how to use that kind of a storage system. . . given our requirements, we would need about a million digital video disks. That is quite a large jukebox to put together. But if we consider a theater data base of 10-100 terabits as I described earlier, a few thousand discs can do the job and we can put such a juke box together.

9. Data Dissemination

The ninth technology area of interest is improved data dissemination. Here we are seeing great strides with global broadcast systems that can give us hundred fold

kinds of improvements in the bandwidth that we can transmit to our forces. What is being developed commercially today is a static direct broadcast TV system where the receiver locations are known and the programming is fixed.

For DOD and intelligence use, we will need a more dynamic system that can deal with users who are moving in the field whose location isn't known *a priori*. Rather than fixed programs, we also need to allow them to be able to interactively change their channel programming.

On the ground, we will need to make better use of the tremendous bandwidth already available through fiber optic transmission media. Wave division multiplexing is one area we are just beginning to exploit.

Earlier, I mentioned that many of these ten enabling technologies were being used to enhance operations in Bosnia. No where is this more evident than in the measures we're taking to improve the communications infrastructure to our forces across Europe and the Bosnia area of operations. We are doing this in two ways: first, using commercial TV satellite technology to provide a direct broadcast communications capability; and secondly, by fielding a wide bandwidth, secure tactical internet through commercial business satellite transponders to allow for distributed collaborative planning among deployed C2 (Command and Control) nodes.

What this means to our forces is that everyone with the proper receive antenna, cryptologic equipment and authentication will have access to the same data as everyone else at the same time reducing the latency in timeliness of information to the lowest levels. But, more importantly, the fielding of this capability will allow us to install and utilize, for this operation, some of the more advanced C4I capabilities being developed by the Government and industry today for use in the Global Command and Control System (GCCS).

10. Planning Analysis Tools

This leads me to the tenth enabling technology. Planning, analysis and training tools are needed to provide us with the ability to move through the databases I described so that we can fuse the collected data to produce useful information and decide who needs that information and disseminate it to the right place.

We will also be able to use these tools to improve our sensor planning. . . they will help us decide the best path ahead to employ each particular collector system in an organized and responsive way.

We also need a set of tools to assist us in deciding what actions we want to take on the battlefield. . . tools that provide us the information to take decisive action and operate within the timelines of our adversaries.

SUMMARY

To summarize, I believe we will soon complete a review of BMD that will provide for the air and missile defense systems needed to protect our forces -- whether it be forces on the move or local and wide-area defense of key staging areas and lodgments. Our task is to put in place the system of systems for achieving dominant battle cycle times.

Along these lines, I feel that upgrades to BMC⁴I capabilities are a priority. . . I strongly support initiatives like the Army's Tactical Operations Center (TOC), designed to contribute to command and control in attack operations as well as all other aspects of missile defense engagement.

We have seen equally encouraging field demonstrations of the Navy's Cooperative Engagement Capability (CEC) which has been deployed in TMD exercises with the Eisenhower battlegroup off the Atlantic coast and in the Mediterranean over the course of the past twelve months as part of the JTF-95 exercise activity.

We must bring machine processing into this game. While the relevant technologies, including Image Understanding, ATR, pattern recognition, cannot support fully automated processing today, they can do a great deal to increase the productivity of our analysts, perhaps by factors of 100-1000.

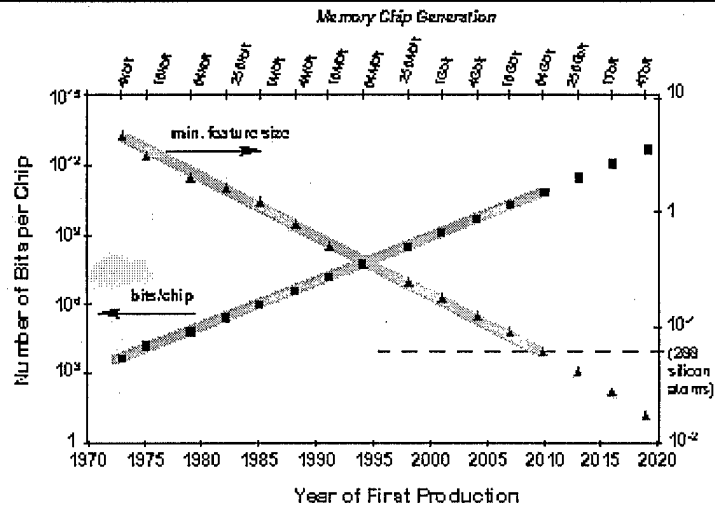
Once exploited, we need to move the information (not necessarily the data) to those who need it. Generally, there is inadequate understanding of who needs what information and what form it is best presented.

Data bases are key to sensor processing and achieving dominant battlefield cycle time. The data bases will be 10s-100s of terabits for a theater and the data streams will be 10s of gigabits/second. The real time data streams must interact with the data bases. We have a lot to learn in the management of the data and the data bases to achieve that kind of interaction.

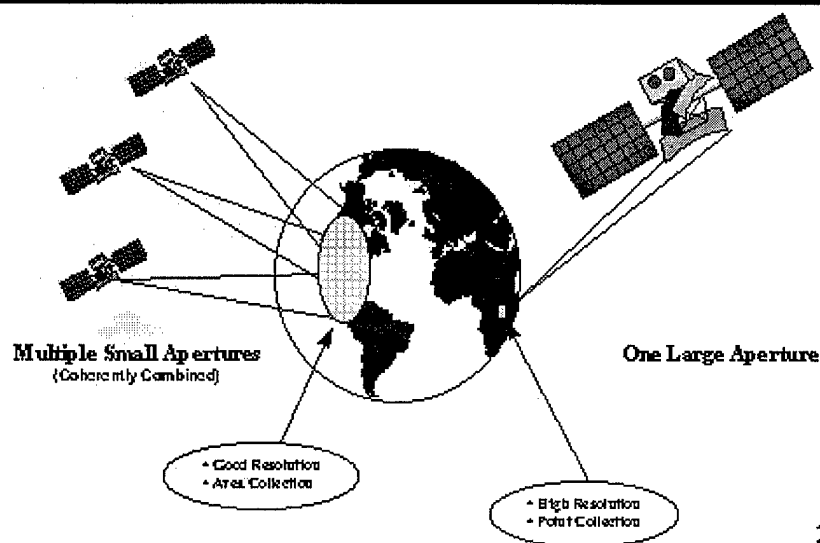
The future effectiveness of our BMC⁴I architecture will depend upon how well we link all air, land, sea and space assets into a common, shared view of the Battlespace. We are a team and you are the key players. I offer my personal support and commitment to you as we work together to achieve dominant action cycle times on the battlefield.

Thank you all.

Moore's Law



Common Grid



Sequential Collection

